# Water and Inca cosmogony: myths, geology and engineering in the Peruvian Andes

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**Abstract:** Water was a key element in the Inca civilization (*c.* AD 1438–1534), both for their crops and as part of their vision of the cosmos. According to myths on the origin of the Incas, their civilization arose from the sea through one of its main manifestations, Lake Titicaca. Throughout the period of Inca dominance, as in some of the cultures that preceded them, water was a sacred element. This vision of the cosmos can be regarded as a hydrogeological model with similarities to the beliefs in force in Europe from the classical period until the end of the seventeenth century. Because of their excellent intuitive understanding of water, the Incas developed a complex irrigation system to channel water to their agricultural lands. Coinciding with the distribution of water, they organized periodical thanksgiving festivals, when farming communities gathered to celebrate the beginning of a new agricultural cycle with songs, dances and festivities. However, the centralized control of water resources introduced in the twentieth century led to the disappearance of many of these traditions and to the replacement of an irrigation system that had proved acceptable, by one that was alien to the customs and history of the country people. This led to the first conflicts over water control. As a result, the vision of the cosmos based on water and rooted in agricultural communities has been lost.

The origin of the Inca culture has not yet been discovered. It has been shown that, of the small kingdoms formed during the Second Intermediate Period in the Cuzco region, one of them was established by force of arms. What we currently know about the Inca Imperial period is well documented in 16th-century Spanish chronicles but they do not provide sufficient information about how that ethnic group was formed and consolidated its power. The Incas' history is full of legends that have reached us through oral tradition, but archaeological data are very scarce. One such legend concerns the ancestors of the Inca lineage, Manco Capac and his wife Mama Ocllo. From them until the last Inca, Atahualpa, the dynastic list known in the 16th century comprises 13 names. However, only from the ninth, Inca Yupanqui, onwards, can one consider the narrated dates and events to be real. It was around 1400 when the Incas established a 'state', after the defeat of the Chancas, a warlike people from the Pampas river valleys. In subsequent centuries, they expanded by conquering the inhabitants of the nearby valleys: the Lupazas, Collas, Huancas and Chancas (1438). At that time, the governor was Pachacutec ('the Earth's saviour'), who earned the title of Inca and became established in Cuzco. Therefore, the Inca civilization commenced as such in the 12th century, although 1438 is usually chosen as the year that the administrative and political structure of the Inca Empire began, or, alternatively, 1450, the start of the 'Late Horizon' period (named from an archaeological perspective). From 1450 onwards, the Inca Empire continued its military expansion and the cultural assimilation of conquered villages. The Inca Empire's northern border was near today's border between Colombia and Ecuador. In the south it reached central Chile and towards the east it reached NW Argentina (Rostworowski 1988).

The Incas divided their geographical space into four geopolitical quarters (*suyus*) which formed the entire territory (Tahuantinsuyu, land of the four quarters), whose centre was located in the city of Cuzco (Qosco, the centre of the world). The Chinchaysuyu (the coast and mountains of north Peru and Ecuador) was NW of Cuzco. The Antisuyu was NE (south and central Andes and the upper Amazon river basin). The Collasuyu (Bolivia and lake Titicaca, north Chile and NE Argentina) was towards the SE. The Cuntisuyu was south of Cuzco, and comprised the south and central coast of Peru and the Andes (Fig. 1; Urton 2003).

In addition to this quadripartite organization, the Incas had a dual vision that enabled them to

*From*: KÖLBL-EBERT, M. (ed.) *Geology and Religion: A History of Harmony and Hostility*. The Geological Society, London, Special Publications, **310**, 17–24.
DOI: 10.1144/SP310.3 0305-8719/09/$15.00 

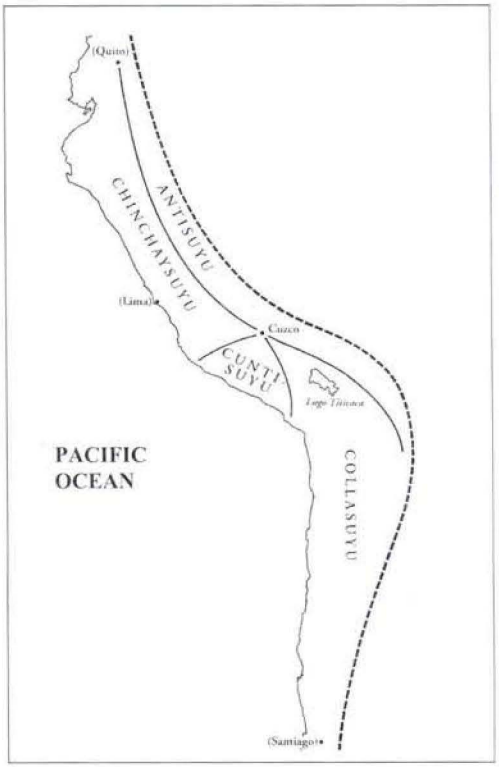


**Fig. 1.** Inca Empire in South America.

structure commercial exchanges based on reciprocal relations between peoples. That duality was justified symbolically by one of the myths about their origins, in which Cuzco was founded with the participation of two dynasties (Hanan and Hurin); these names were later transferred to the Incas' administrative reality. Each of their cities, starting with Cuzco itself, was divided into two halves: Hanan (the upper half) and Hurin (the lower half). Even the Tahuantinsuyu was divided into two halves: Hanansaya (with the Chinchaysuyu and the Antisuyu) and Hurinsaya (Collasuyu and Cuntisuyu) (Zuidema 1991).

The third component of their view of the world was a tripartite organization. Their world was stratified into three levels: Hanan Pacha (the higher world, inhabited by the main gods in their pantheon: Viracocha, Pachacamac, Mamacocha, etc.), Kay Pacha (the middle world or Earth's surface, inhabited by living beings) and Hurin Pacha (the lower world, inhabited by the dead). The springs (*pukyu* in Quechua), caves and all types of openings in the Earth's crust were considered to be communication routes between Hurin and Hanan Pacha (Sherbondy 1992). That tripartite organization also manifested itself in real life with the existence of three hierarchies: the Collana (Inca chiefs) the Cayao (the defeated non-Inca people) and the Payan (a group formed by the union of Inca and non-Inca people).

In addition to these symbolic and organizational expressions, water was the focal point of the Inca cosmogony (Mazadiego & Puche 2004; Bosch 2005). The Inca civilization considered itself as arising from water, and, it extended its control through water. There was a very close relationship between cosmology, religion, and social and political structure during the Inca Empire (D'Altroy 1987; Williams & D'Altroy 1998). In the Andean cosmos model, the lower part was filled with the original sea ('the cosmic sea'). When the upper surface of these deep waters reached the surface of the land, lakes and rivers emerged. The sea was regarded as the Mother (*Mama Cocha*) and the lakes, rivers and lagoons as daughters (*Cochas*). The deep waters followed a 'centrifugal' movement, from inside to outside the Earth (Sherbondy 1984), creating a flow as if they were underground rivers that emerged in the shape of springs; these springs, in turn, fed the rivers that flowed into the sea. Thus the Incas considered that surface waters and underground waters originated from the sea.

## The Andean vision compared with European hydrogeological theories

Until the seventeenth century, in Europe it was generally accepted that the waters in rivers and springs had no connection at all with atmospheric precipitation, which was believed to be insufficient to contribute to the flow of rivers. Furthermore, people believed that the Earth's surface was too impermeable for rainwater to filter through.

The first hydrogeological theories were developed by the Greeks. Thales of Miletus, around 650 BC, held that springs and rivers were fed by water from the ocean that filtered into the land and that, eventually, as a result of high pressure, emerged as springs (Puche 1996). This theory displays many common aspects with the Inca vision of the cosmos: a closed circuit where the rivers are generated by seawater that, once it has filtered through the subsurface, creates underground watercourses that form the rivers on the surface. Plato (427–347 BC) also held this hypothesis, although he asserted the existence of a great cavern, which he called Tartarus, into which all surface waters flowed and from which they emerged (Plato 1985).

During the Roman period, Lucretius and Pliny endorsed the Greek theories; Lucretius, in his book *De Rerum Natura* (Lucretius 2003; Pliny 1995), postulated a hydrological cycle in which water evaporates from the surface of the land and

sea and falls back as rain. That idea also appeared in the Inca culture, which personalized this into elements of their cosmogony. The god Huiracocha travelled from lake Titicaca to the ocean, which symbolized the flow of the water along the rivers (*mayu* in Quechua) to the river mouth. The water was then drunk by the Llama constellation (*yacana*), the flow process would begin through the Milky Way (also called *mayu* like the rivers) and the water would finally return to Earth as rain (Zuidema & Urton 1978).

During the European Middle Ages and until the end of the sixteenth century, it was still believed that all water came from the sea. This idea was based on a number of biblical passages, which were taken literally, such as the following: 'All the rivers run into the sea; yet the sea is not full; unto the place from whence the rivers come, thither they return again' (Ecclesiastes 1: 7–9). These ideas continued to be upheld until the seventeenth century. Scientists such as Kepler (1571–1630), Kircher (1602–1680) and Descartes (1596–1650) held that all water came from the sea (Kircher 1664; Solís 1990). Descartes, for example, stated:

> There are large cavities full of water under the mountains, where the heat from the light of the sun continuously produces vapours, which, being nothing more than tiny droplets of water separated from each other, escape through the pores of the earth and reach the highest plains and mountains where they regroup and form the springs, which flow down the valleys, join, form rivers and eventually flow into the sea. Although this process causes great amounts of water to escape from the said cavities under the mountains, they never empty completely. This is because there are many channels through which seawater reaches the said cavities in the same proportion as water escapes to the springs (Descartes 1644).

Hydrogeology emerged as a science, towards the end of the seventeen century, when scientists such as Palissy or the priest Pierre François rejected the Greek water cycle theories (François 1563; Palissy 1957).

## The sacred nature of the Inca hydrogeological theory: the origins of the Inca universe

The Inca hydrogeological model was the basis of the cosmological vision that explained their origins. According to their beliefs, the Inca universe originated in the cosmic sea, although Inca tradition also referred to one of the manifestations of this sea, Lake Titicaca, as the birthplace of the Sun, the Moon and the stars. A vertical movement led to the creation of the rivers and lakes, from which water filtered through the subsurface to feed the underground watercourses. Therefore, in the Andean world, water classification was of prime importance because of its symbolic significance. There was water that flowed along the surface, water that flowed along the subsoil and seawater. Seawater had a major significance in purification and fertility rituals, and, like seashells, played a major role in the worship of hills during the rain ceremonies (Urton 1981).

In most Inca settlements water was considered as feminine; it was regarded as the sacred milk that flows from the hills and mountains (considered as male). In 1571, Polo de Ondegardo stated that the Incas 'offered seashells to the fountains and springs, affirming that the shells were the daughters of the sea, the mother of all waters' and that they also presented shells to the hills to plead for rain (Polo de Ondegardo 1917).

The Incas believed that they had to pray to the hills and mountains to favour the start of the rains. Thus there was an association between the 'forefathers (ancestors)–origin–founding of villages–water (upwellings, lakes)' group and the 'mountain–water–fertility' group. In effect, the mountains were considered as divinities that acted to bring about rain in the places inhabited by the god Wamani and all the other gods who controlled the water circulation through the canals (Reinhard 1983; Farfán 2002). This is the reason for most of the pre-Hispanic settlements being located on hills and oriented towards their *pacarina* or place of origin (a lake or hill).

## The Inca origin: Cuzco and water

Of the various versions of the mythical origin of the Incas, the most widespread was compiled by the chroniclers Martín de Murúa and Guaman Poma de Ayala. According to them, the Inca ancestors crossed the subsoil from Lake Titicaca to the Pacaritambo cave, which is around 33 km from Cuzco. The site's ruins are currently called Mauqallaqta ('Old City') (Martín de Murúa 1964; Guamán Poma de Ayala 1980). From that site, the Inca ancestors went to the valley of Cuzco where, after conquering the inhabitants, they established political and administrative structures that gave rise to their Empire. The Incas considered that they were the first people to have been created, so they had the honour of dressing in clothes decorated with gold, the symbol of the Sun, and of wearing large ceremonial ear flaps (*orejeras* or *orejones*) (Cieza de León 1943; de Betanzos 1987). They believed that all the people of the world were created in Lake Titicaca and then moved through the underground watercourses (the 'veins of Mother Earth', *Pacha Mama*), until they came to the surface through springs, upwellings, rivers, lakes and caves. These places were called *pacarinas* ('places where nations dawned') (Earls & Silverblatt 1976).

## Rituals of foundational water

When they chose a new governor, the Incas would take water from Lake Titicaca in memory of their origins. Later, given the expansionist nature of their culture, when they settled in a new place, they would take water from the former *ayllu* (village or community), pour it out and give the name of their old upwelling place to the new settlement (Albornoz 1984). It was a way of legitimizing their power through the original water from Lake Titicaca. The most important surface water bodies for the Inca were Lake Titicaca, Lake Choclococha (central Andes) and the sea (for the coastal villages, both the Paracas area and the NW coast of Peru) Water thus became a unifying element for the villages, the Incas (the conquerors) and the new settlements (the conquered). The objective was to ensure complete integration in the new site. For example, Lake Coricocha, around 12 km from Cuzco, was the mythical reference of the Huayllacan people. When the Inca Roca married Mama Micay, the woman-chief of the Huayllacan, a commitment was established between the two peoples, and recorded as follows by local tradition: 'The Inca Roca married a woman named Mama Micay, the chief of the Huayllacan people.... Once the festivities were over, the now married woman said that those lands did not have sufficient water for irrigating the corn fields. So the Inca Roca brought the waters and it became a family duty to distribute the water with which the valley was irrigated' (Cobo 1957).

At present, the farmers believe that the water used for irrigating their fields comes from Lake Coricocha and that it reaches them through underground canals built by the Incas to endorse their common origins after the marriage between the Inca and the woman-chief. The idea was to establish a common territorial unit based on water distribution in the area of the old village of Guayllamán, which became part of the Antisuyu, one of the four Inca political divisions.

## The cult of water

The cult of water manifested itself in diverse ways in the Inca world. In addition to appearing in the legends of their origins, water also appeared through the *paccas* (i.e. the objects used to adore the liquid element). In the ceremonies that took place in the city squares, *chicha* (an alcoholic beverage made from maize) was poured over the idols and into the irrigation canals. According to the Inca beliefs, water had the power to wash away impurities and, therefore, stave off evils and illnesses. One of these festivities, perhaps the most important one, took place in Cuzco, just before the start of the rainy season. A procession took place with four groups (symbolizing the four divisions of the Inca Empire). One group would go to the river Collasuyu, another to the river Quiquijana, another to the river Apumírac and the other to the river Urubamba. Once they had bathed themselves in the river, they believed that they had staved off their misfortunes. Meanwhile, the inhabitants of Cuzco bathed themselves in the fountains (Zuidema 1991).

## Hypothesis on the Inca's geological knowledge

Irrigation water was a very important element in the consolidation and survival of the Inca civilization as it enabled them to grow corn, a vital product for their economy and religion, and maintain pastures for llamas and alpacas. It has been proved that the layout of some cities was based on hydrological criteria. The most obvious case is Cuzco, where administrative districts were organized, inside the metropolitan area, based on irrigation systems (Sherbondy 1987); that is, first the channels that transported the water were installed and later the city was divided into districts.

The Cuzco cosmogony was based on the dual division of Hanan Cuzco (the higher quarters) and Hurin Cuzco (the lower quarters), based on the hydrological features of the Huantanay River, which irrigates the district. Hanan belonged to the hilly and mountainous areas, the source of the life-giving rivers, and Hurin belonged to the valley, the widening of the basin and the flow of the water through the fields. Each of these parts was dedicated to a dynastic ancestor, who was associated with the mythical construction of the hydraulic works and the channelling of the water. The canals built by the Inca predecessors were considered to be sacred and thus were included in the myths about their origins. The Incas worshipped their ancestors, so, to make the history of their people sacred, in their legends they re-created the fact that those predecessors discovered the water sources that they later turned into canals (Sherbondy 1982).

This dual hydrological principle also led to political and social hierarchies. Hanan Cuzco was more important than Hurin Cuzco, simply because it was linked to the source of the waters. Also, considering not only the central area of Cuzco but also its outlying neighbourhoods and satellite villages, one can see that a radial pattern of organization was designed based on a series of lines (*ceque* in Quechua) that could be considered as radii that divided the territory into sectors (Sherbondy 1982, 1984). Each half ('upper' and 'lower' areas) was, in turn, divided by lines that originated from

the city centre. The purpose of this layout was to indicate the sources of water for the irrigation channels in a town and connect them symbolically at a central point, and to indicate the borders between areas by radiating lines.

This radial organization has been confirmed in many Andean towns, such as, for example, in present-day San Andrés de Machaca (Bolivia). It is, therefore, not surprising for Polo de Ondegardo, the colonial administrator (magistrate) who investigated the religion, customs and superstitions of the Inca, to have written, in 1571, that 'it is not possible to understand the organisation of the Inca Empire without studying the "*ceque*" system' (Fig. 2). The description of the Cuzco *ceques* commenced in 1653, when Father Bernabé Cobo identified 41 *ceques* that radiated from the temple of Coricancha.

Bauer (2000) studied the 328 *huacas* (sacred sites) described by Cobo, and classified them based on their typology (Table 1). We can see that the Inca chose manifestations directly or indirectly linked to geology (streams, rocks, geological formations and quarries) as their sacred places. However, these conclusions are difficult to extrapolate to the Inca reality. Writing was unknown by the Inca culture. Therefore, everything that we know is based on chronicles that were written years after the end of that empire, especially those written by Europeans. Because we do not have any documented confirmation of the degree of geological knowledge of the Inca people, anything that we might say is only a hypothesis. Nevertheless, according to Menegat & Porto (2007), we can accept that the Inca not only based most of their cosmogony on water but they also based this

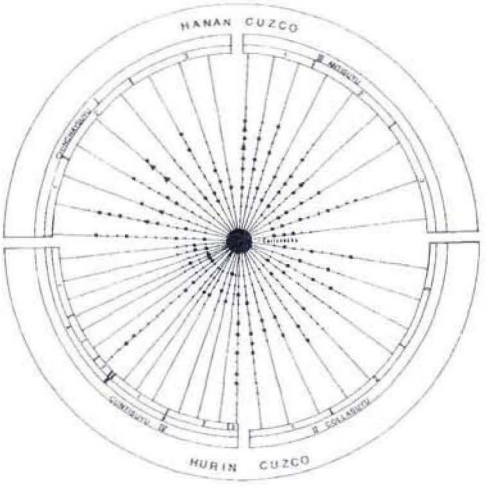


**Fig. 2.** Imaginary lines (*ceques*) with a group of *huacas* from Coricancha in Cuzco (Sherbondy 1987).

**Table 1.** Huacas *related to geological elements, according to Bauer (2000)*

| Type of *huaca* | Number | % |
|---|---|---|
| Water sources | 96 | 29 |
| Rocks and geological formations | 95 | 29 |
| Hills and mountains | 32 | 10 |
| Inca palaces and temples | 28 | 9 |
| Plains | 28 | 9 |
| Tombs | 10 | 3 |
| Gullies | 7 | 2 |
| Caves | 3 | 1 |
| Quarries | 3 | 1 |
| Stone seats | 3 | 1 |
| Sunset signs | 3 | 1 |
| Trees | 2 | 1 |
| Pathways | 2 | 1 |

intellectually on what those researchers defined as 'landscape geoforms' (Farina & Belgrano 2004). That hypothesis is corroborated by the relatively large number of *huacas* related to geology. Menegat & Porto also suggested that the Inca culture considered geological faults as a landscape unit for their cities, especially around Cuzco. Those researchers considered that the Incas constructed around faults based on their scale and the blocks of rock that they could cut for use as walls. Indeed, in both Machu Picchu and Ollantaytambo, or the Inca's Baths, faults were interpreted as phenomena in which water was replenished and as an ideal location for urban or ceremonial settlements.

## Pre-Hispanic irrigation systems

Several methods of channelling water were used by the Incas and other people in the Andes. Sunken fields (*huachaques*) drew water from the subsoil by filtering it, and plants such as reed mace and rush were subsequently sown. Terraces and plots were constructed in the mountains, with the aim of limiting the loss of nutrients in spillway waters to lower levels. Sunken gardens (*chacras* or *mahmaes*), used in coastal areas, were constructed by removing loose sand and earth to obtain a damp basin of subsoil that was favourable for sowing. Sunken basins (*qòchas*) followed a similar procedure to that used for the *chacras*. Canal systems, especially in the valleys, helped to move water from its collection points to the cultivated areas. *Waru Waru*, in the province of Puno, was carried out using raised embankments over the land surface, alternating canals with bands of stones on the basin (Deza 2002).

The only irrigation system that was used was underground aqueducts (Fig. 3), such as the one in Cantayoc (Nazca). They were narrow canals designed to take the water to a number of storage

**Fig. 3.** Underground aqueduct in Nazca (photograph by Luis F. Mazadiego).

points (*cochas*) from where it was taken to the fields through canals. The walls of the aqueducts were covered with stones fitted together with the help of guarango wood. Throughout the aqueducts, there are wells (*eyes*) that ventilate the system and through which the canals could be cleaned. These constructions are still the object of a ritual in which the farmers give thanks for the water that reaches their lands; this tradition is related to the Inca custom of worshipping the initial waters that arise from the subsoil as the most sacred ones, as a result of having a close contact with *Mama Pacha*.

## Irrigation systems today

The dual division or organization (Ossio 1976) has had a significant effect on the spatial, social and political reality of Andean communities since pre-Columbian times. The Hanansaya and Hurinsaya organization was a key element in the geopolitical stability of the Inca Empire. This dual nature inspired a clearly symbolic element that was also linked to fertility. Extensive evidence has been collected that alludes to a number of traditional festivities during which the community was divided into two parts, as a way of representing both sexes and, by means of games, plays and prayers, they invoked the fertility of the land through irrigation or, more generically, rainfall. Even today, Andean agricultural communities elect a so-called 'water mayor', who holds this position for about 50 days, the duration of a complete irrigation water distribution cycle.

In the Inca villages and now in the Andean world, water is the origin of life. Sharing water becomes a kinship relationship, just as in the Inca Empire it was used to seal friendship between villages through a unified cosmogony. The irrigation technology was transmitted from generation to generation as a cultural heritage that was necessary for survival. Water was regarded as sacred and so were the irrigation canals, such as 'Achicaria', located in Ica, south Peru. The legend related to this canal is as follows: 'In 1412, the Inca Pachacutec ... embarked on the conquest of the Ica valley. In one of his raids, he fell in love with a maiden named Mama Chira, whom he courted and told her to ask him for anything that she needed. She replied that she would be satisfied if he provided water to her community. In the next ten days, 40,000 Inca soldiers opened a riverbed to take the water to that place'. As we have seen, water was used as a unifying element between two groups of people with opposing interests: one wants to conquer new territories whereas the other wants to defend itself from the invaders (Oré 2005).

It must be stressed that this dual distribution of the irrigation system and of other local activities (e.g. grazing, agriculture) continued even after the arrival of the Spanish Conquistadores. These, by means of the so-called *encomiendas* (concessions of native labour) based their organization on the *sayas* (Hurin and Hanan). Later, after independence, this division into two parts continued, for example, in the collection of taxes, which was performed independently in each half.

This dual organization remained the essence of country life until the middle of the twentieth century, when a number of administrative reforms reorganized the districts. However, extensive proof of its existence can still be found, both at folkloric level (festivities, celebrations) and in the use of the land (in the higher regions, farmers still take their animals to graze in the same upper districts or Huaran).

## Conclusions

Inca cosmology presents many common points with the hydrogeological beliefs held in Europe from the Greek (Thales of Miletus, Plato) and Roman period (Lucretius, Pliny) until the end of the seventeenth century (Kepler, Kircher, Descartes), when finally the theoretical models that led to the birth of hydrogeology as a science were developed. The Incas held that rivers, springs and lakes stem directly from the sea and that, through underground courses, seawater rises to the surface to create a closed cycle. Furthermore, the Incas identified evaporation and rainfall as additional factors. This hydrogeological theory was given a sacred quality, as it was part of the foundational myth of the Inca Empire, based on water from the sea through one of its most significant manifestations, Lake Titicaca. This understanding of hydrogeology enabled the Inca people to base their entire political,

social, economic and religious organization on the channelling of water through sophisticated irrigation systems, which were linked to Andean ethnohistory by religious symbolism.

Some researchers (Alva Plasencia *et al.* 2000; Gelles 2000) have considered that the present water distribution system, centralized by local political agencies, has breached the ancient tradition of sharing irrigation water and has led to a number of social conflicts. Furthermore, one of the major demands presented by the native people has been the preservation of the purity of water that has been polluted by industrial discharges. For native communities located near mines, one of their chief demands harbours a symbolic quality, linked to their religious beliefs. They demand the right, not only to preserve their rivers, which are affected by uncontrolled discharges from mineral treatment plants, but also to maintain their relationship with water by means of communal control over it.

On this subject, the conclusions of the second World Water Forum (2000) stated that: 'having studied the documents presented to the Forum, native populations and their traditional values, knowledge and systems have been ignored during the present process'. In a way, the policies of the countries in the Andean region have led the native peoples to renounce their traditional beliefs and their ethnic identity in exchange for progress. As a result, the new water control strategies have increased social conflict, which had been kept to a minimum by the irrigation structure used during the age of the Incas.

The authors are indebted to S. Newcomb and an anonymous reviewer for their reviews, which have greatly improved the quality of the manuscript. We would also like to thank the San Agustín University (Arequipa, Peru), San Antonio Abad University (Cusco, Peru) and Jorge Bassadre University (Tacna, Peru) for their support of this research.

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